

WHAT IS CLAIMED IS:

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1. A method for optically coupling optical components, comprising:

providing a base substrate;

10 providing a plurality of optical components including a light source and an adjustable optical element;

forming an optical subassembly by passively aligning said plurality of optical components using a jig and joining said plurality of optical components to said base substrate;

15 passively aligning said optical subassembly to an optical transmission medium; and

adjusting said adjustable optical element such that optical power of light emitted by said light source and directed into said optical transmission medium, is maximized.

20 2. The method as in claim 1, in which said jig includes a jig stencil having a corresponding plurality of openings therethrough; and

25 said passively aligning includes positioning said plurality of optical components within said corresponding plurality of openings.

30 3. The method as in claim 1, in which said adjustable optical element comprises a microelectromechanical structure (MEMS) and said adjusting includes causing said light source to emit light and mechanically adjusting said MEMS.

35 4. The method as in claim 3, in which said MEMS includes a mirror and said adjusting includes adjusting a position of said mirror

5      5.    The method as in claim 1, in which said passively aligning includes positioning said optical components to satisfy an alignment tolerance of one of about +/-10 microns and about +/-5 microns.

10      6.    The method as in claim 5, in which said joining includes forming a solder layer between each of said plurality of optical components and said base substrate, and heating to join said optical components to said base substrate such that said plurality of optical elements continues to satisfy said alignment tolerance.

15      7.    The method as in claim 1, in which said passively aligning said optical subassembly to an optical transmission medium, includes the use of at least one mechanical guide.

20      8.    A method for optically coupling optical components, comprising:

    providing a base substrate;  
    providing a plurality of optical components including a light source;  
    providing a jig;  
25      aligning said plurality of optical components using said jig such that said light source is optically aligned to further of said optical components;  
    forming a solder layer between each of said plurality of optical components and said base substrate; and  
30      joining said optical components to said base substrate such that said light source remains optically aligned to said further of said optical components.

35      9.    The method as in claim 8, in which said plurality of optical components includes an adjustable optical element and

5      said light source emits light, and further comprising providing an optical transmission medium and using passive alignment to optically couple said optical transmission medium to said light source.

10      10. The method as in claim 9, in which said adjustable optical element comprises a microelectromechanical structure (MEMS) and further comprising adjusting said MEMS such that optical power of light emitted by said light source and directed into said optical transmission medium by said further of said optical components, is maximized.

15      11. The method as in claim 8, in which said joining comprises heating to solder said plurality of optical components to said base substrate such that said optical components satisfy an alignment tolerance of +/-5 microns.

20      12. The method as in claim 8, in which said jig includes a corresponding plurality of openings therethrough, said providing includes positioning said jig over said base substrate, and said aligning includes positioning said plurality of optical components within said corresponding plurality of openings.

25      13. The method as in claim 12, in which said positioning includes positioning at least one of said optical components within a corresponding one of said openings and contacting a retractable portion that forms part of a border of said corresponding opening, said retractable portion resiliently urging said at least one of said optical components into alignment position.

5 14. The method as in claim 13, in which said joining comprises heating and further comprising cooling after said heating, and in which said jig has a thermal coefficient of expansion different from a thermal coefficient of expansion of said base substrate and said retractable portion retracts to allow said jig to move relative to said optical components, during said cooling.

10 15. The method as in claim 13, in which said positioning includes retracting said retractable portion from said opening then inserting said at least one of said optical components within said corresponding opening.

15 16. The method as in claim 8, in which said joining comprises heating to join said optical components to said base substrate and further comprising subsequently cooling, and said jig moves relative to said optical components thereby preventing said joined optical components from moving with respect to said base substrate, during said step of cooling.

20 17. The method as in claim 8, further comprising providing a jig clamp having a base section coupled to a movable cover, and in which said providing a base substrate comprises positioning said base substrate on said base section, and further comprising positioning said cover over said plurality of optical components to urge said plurality of optical components toward said base substrate.

30 18. The method as in claim 17, in which said cover includes at least one protuberance and said positioning said cover includes resiliently urging said plurality of optical components toward said base substrate.

19. The method as in claim 17, wherein said base section includes a protuberance and said jig includes an alignment opening bounded by at least one retractable surface and said positioning includes said alignment opening receiving said protuberance therein.

20. The method as in claim 8, in which said joining includes soldering said optical components to said base substrate substantially simultaneously.

21. A method for optically coupling optical components, comprising:

15      providing a jig;  
         providing a base substrate;  
         providing a plurality of optical components including a light source; and

20      forming an optical subassembly by passively aligning said plurality of optical components using only said jig and joining said optical components to said base substrate such that said optical components satisfy an alignment tolerance of +/-5 microns.

22. The method as in claim 21, in which said plurality of optical components includes an adjustable optical element and further comprising passively aligning said optical subassembly to an optical transmission medium and adjusting said adjustable optical element to maximize optical power of light emitted by said light source and directed into said optical transmission medium.

23. The method as in claim 22, in which said adjustable optical element is a MEMS having a mirror and said adjusting comprises positioning said mirror.

5      24. An apparatus comprising a jig stencil having a plurality of openings that receive a corresponding plurality of optical components therein and passively optically align said plurality of optical components to one another, at least one of said openings bounded by a retractable portion which contacts an associated one of said plurality of said optical components received in said opening.

10      25. The apparatus as in claim 24, in which said jig stencil passively aligns said plurality of optical components to one another to satisfy an alignment tolerance of +/-5 microns.

15      26. The apparatus as in claim 24, in which at least one of said openings is bounded in part by a fixed reference surface that positions an associated one of said plurality of said optical components within said opening, and is movable with respect to said plurality of optical components that are fixed with respect to each other, during thermal processing.

20      27. The apparatus as in claim 24, further comprising a jig clamp for securing said plurality of optical components disposed within said openings, to a base substrate, said jig clamp including a base and cover.

25      28. The apparatus as in claim 27, in which said base receives said base substrate thereon and said cover is movably coupled to said base.

30      29. The apparatus as in claim 27, in which said cover includes mechanical protuberances that resiliently urge at least one of said optical components toward said base substrate.

30. The apparatus as in claim 27, wherein said jig  
stencil further includes an alignment feature that aligns said  
5 jig stencil to said base.

31. The apparatus as in claim 30, wherein said base  
includes a protuberance and said alignment feature comprises a  
peripheral opening bounded at least partially by a retractable  
10 surface, said jig stencil aligned to said base when said  
protuberance is received within said opening.

32. An apparatus comprising:  
an alignment jig,  
15 an optical subassembly comprising a plurality of optical  
components including a light source, and  
an optical transmission medium,  
said optical subassembly and said plurality of optical  
components arranged such that light emitted by said optical  
20 source is directed to said optical transmission medium by  
further of said plurality of optical elements, and said  
optical subassembly includes alignment tolerances obtainable  
with said alignment jig.

33. The apparatus as in claim 32, in which said optical  
components of said optical subassembly are aligned within an  
alignment tolerance of +/-5 microns.

34. The apparatus as in claim 32, in which said  
30 plurality of optical components includes a  
microelectromechanical structure (MEMS) component positioned  
such that optical power of said light emitted by said light  
source and directed to said optical transmission medium is  
maximized.

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35. The apparatus as in claim 34, in which said MEMS component includes an adjustable mirror.

5      36. The apparatus as in claim 32, in which said plurality of optical components further includes a collimating lens and a focusing lens positioned along an optical path of light emitted by said light source.

10      37. The apparatus as in claim 32, in which said alignment jig includes a jig stencil including a plurality of openings for receiving said optical components, at least one of said openings bounded in part by a retractable portion.

15      38. The apparatus as in claim 37, in which said jig stencil and said base substrate include different coefficients of thermal expansion and said retractable surface portion substantially precludes said optical components from moving with respect to said base substrate when said base substrate and said optical components are heated then cooled.

20      39. An optical subassembly comprising a plurality of optical components including a light source and an adjustable microelectromechanical structure and satisfying an alignment tolerance of +/-5 microns, said plurality of optical components optically aligned to one another using only a jig.

25      40. The optical subassembly as in claim 39, further including an optical fiber optically coupled to said plurality of optical components such that light directed from said light source to said optical fiber is maximized.

30      41. An optical subassembly comprising a plurality of optical components including a light source and an adjustable



microelectromechanical structure and satisfying an alignment tolerance of +/-5 microns, said plurality of optical components optically passively aligned to one another using a jig.

42. The optical subassembly as in claim 41, further including an optical fiber optically coupled to said plurality of optical components such that light directed from said light source to said optical fiber is maximized.

43. An apparatus comprising an optical transmission medium and an optical subassembly having optical components including a light source and an adjustable microelectromechanical structure, said optical components aligned to one another using only a jig and configured such that the amount of light from said optical source that enters said optical transmission medium is maximized.

44. The apparatus as in claim 43, wherein said optical transmission medium is passively aligned to said optical components of said optical subassembly.

45. An apparatus comprising an optical transmission medium and an optical subassembly having optical components including a light source and an adjustable microelectromechanical structure, said optical components passively aligned to one another using a jig and configured such that the amount of light from said optical source that enters said optical transmission medium is maximized.

46. The apparatus as in claim 45, wherein said optical transmission medium is passively aligned to said optical components of said optical subassembly.